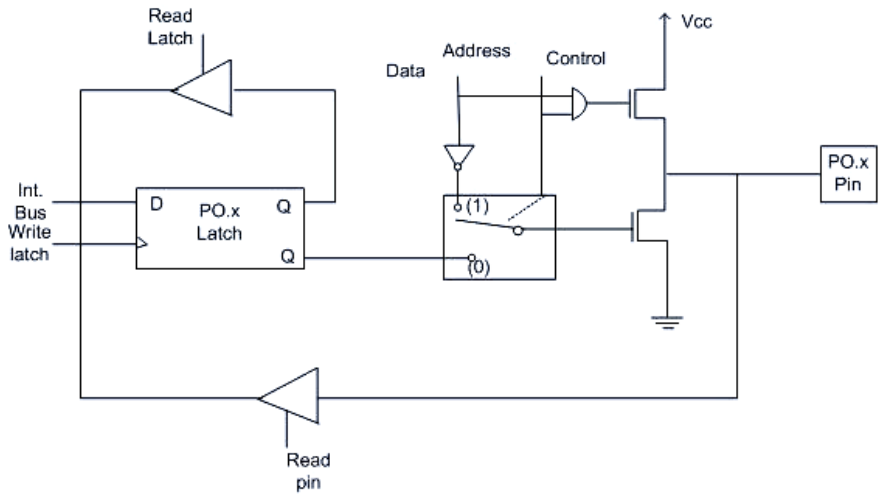
The Microcontroller Architecture:

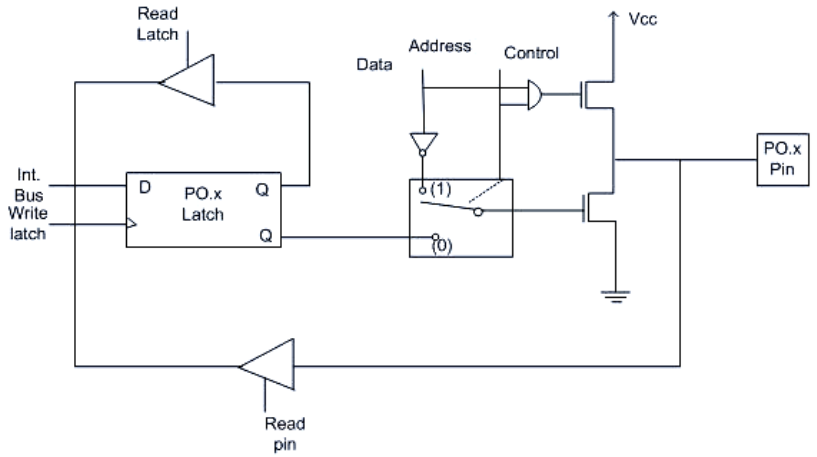
- Introduction to 8051 Microcontroller,
- Architecture,
- Pin configuration,
- Memory organization,
- Input /Output Ports, Counter and Timers,
- Serial communication, Interrupts

8051 I/O ports

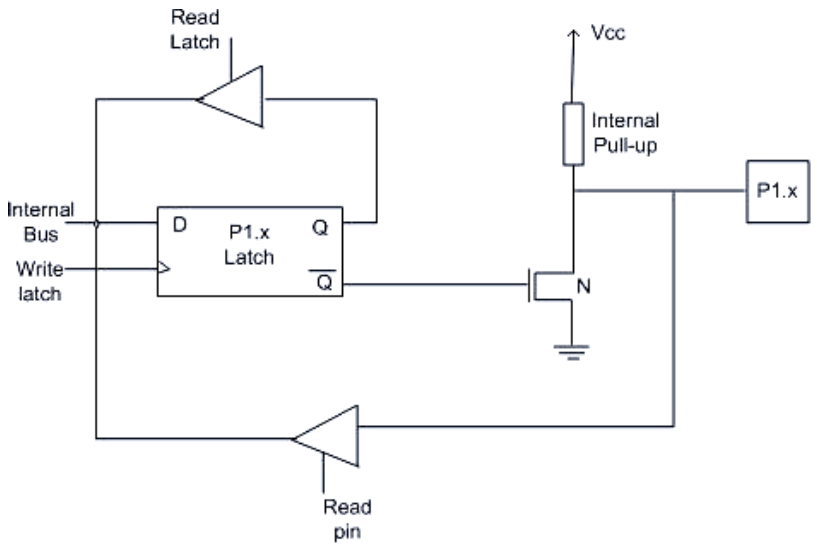
- 8051 microcontroller have 4 I/O ports each of 8-bit, which can be configured as input or output. Hence, total 32 I/O pins allows the microcontroller to be connected with the peripheral devices.
- Pin can be configured as 0 for output and 1 for the input.
- 1) PORT 0
- P0 can be used as a bidirectional I/O port or it can be used for address/data connected for accessing external memory. When control is 1 the port is used for address or data interfacing. When the control is 0 then the port can be used as a bidirectional I/O port.



- **PORT 0 as an Input Port**
- If the control is 0 then the port is used as an input port and 1 is written to the latch.
- In this type of situation both the output MOSFETs are off.
- Since the output pin has floats therefore, whatever data written on pin is directly read by read pin.
- **PORT 0 as an Output Port**
- If we want to write 1 on pin of P0, a '1' written to the latch which turns 'off' the lower FET while due to '0' control signal upper FET also turns off.
- Suppose we want to write '0' on pin of port 0, when '0' is written to the latch, the pin is pulled down by the lower FET. Hence the output becomes zero.

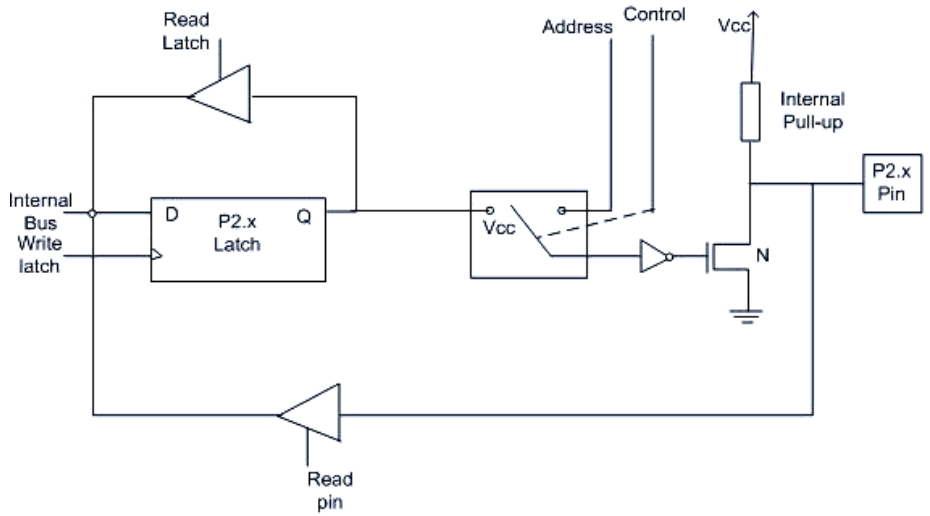


- 2) PORT 1
- PORT 1 is dedicated only for I/O interfacing. When used as an output port, not needed to connect additional pull-up resistor like port 0.
- To use PORT 1 as an input port '1' has to be written to the latch. In this mode 1 is written to the pin by the external device then it read fine.



- 3) PORT 2

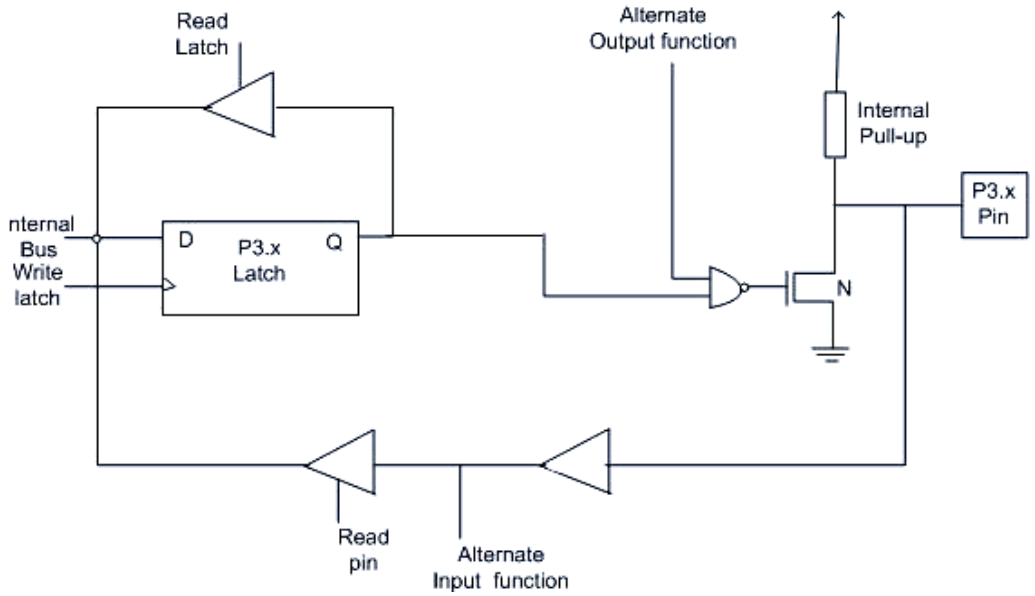
- PORT 2 is used for higher external address byte or a normal I/O port. Here, the I/O operation is similar to PORT 1. Latch of PORT 2 remains stable when Port 2 pin are used for external memory access.



- 4) PORT 3
- Following are the alternate functions of PORT 3:

PORT 3 Pin	Function	Description
P3.0	RXD	Serial Input
P3.1	TXD	Serial Output
P3.2	INT0	External Interrupt 0
P3.3	INT1	External Interrupt 1
P3.4	T0	Timer 0
P3.5	T1	Timer 1
P3.6	WR	External Memory Write
P3.7	RD	External Memory Read

- It works as an I/O port same like port 2. Alternate functions of port 3 makes its architecture different than other ports.



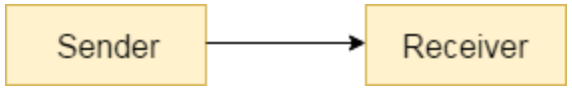
Counter and Timers

- As their names suggest, their main purpose is to measure time and count external events. Besides, they can be used for generating clock pulses to be used in serial communication, so called Baud Rate.
- In application software development, delay is one of the important factors that affects a development process of software.
- The counters and timers are hardware component of microcontroller, which is used in many applications for providing the precious time delay with count pulses.
- A timer is a specialized type of clock which is used to measure time intervals.
- It is a device that counts down from a specified time interval and used to generate a time delay, for example, an hourglass is a timer.
- A counter is a device that stores (and sometimes displays) the number of times a particular event or process occurred, with respect to a clock signal.
- It is used to count the events happening outside the microcontroller.
- In electronics, counters can be implemented quite easily using register-type circuits such as a flip-flop.

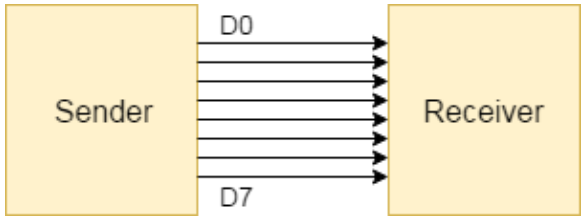
Counter	Timer
The register is incremented considering 1 to 0 transitions at its corresponding to an external input pin (T0, T1).	The register incremented for every machine cycle.
A counter uses an external signal to count pulses.	A timer uses the frequency of the internal clock signal, and generates delay.
Maximum count rate is 1/24 of the oscillator frequency.	Maximum count rate is 1/12 of the oscillator frequency.

Serial Communication

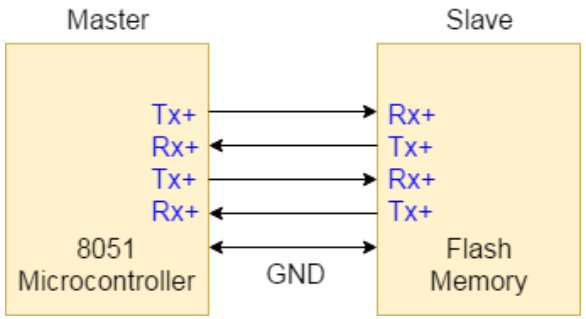
- Computer transfer data in two different ways:-
- Serial transfer: In serial transfer, data is transfer to device located many meters away this method is used for long distance data transfer.



- **Parallel transfer**: In parallel transfer, data is transferred in 8 or more lines. In this wire conductor is used for transferring data to a device that is only a few feet away.

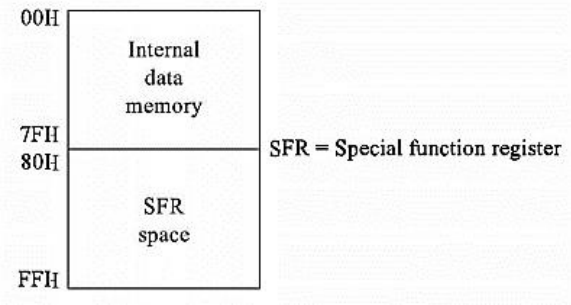


- Serial communication is mostly used for transmitting and receiving the signal.
- The 8051 microcontroller is consisting of **Universal Asynchronous Receiver Transmitter (UART)** used for serial communication.
- The signals are transmitted and received by the Rx and Tx pins of microcontroller.
- The UART take individual bytes of data and sends the individual bits in a sequential manner. The registers are used for collecting and storing the data inside a memory. UART is based on half-duplex protocol. Half-duplex means transferring and receiving the data, but not at the same time.
- Let's see the block diagram representation of showing serial communication between flash memory and 8051 microcontroller:



Memory Organization of Intel 8051

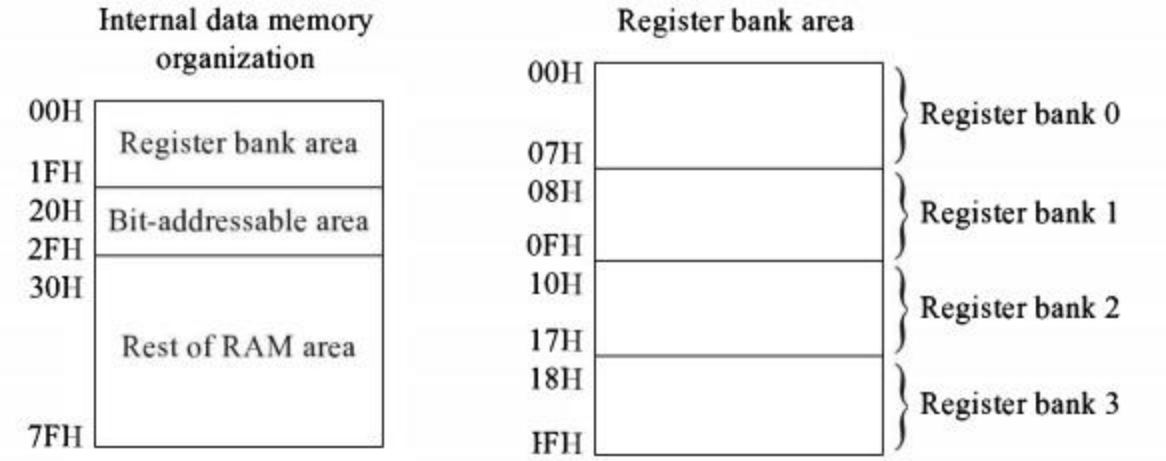
- The internal data memory of **8051** is divided into two groups.
- These are a set of eight registers and a scratch pad memory.
- These eight registers are R0 to R7.
- The address range 00H to 07H is used to access the registers, and the rest are scratch pad memory.
- 8051 Provides four register bank, but only one register bank can be used at any point in time.
- To select the register bank, two bits of PSW (Program Status Word) are used.



So the following addressing can be used to select register banks.

Address Range	Register Bank
00H to 07H	Register Bank 0
08H to 0FH	Register Bank 1
10H to 17H	Register Bank 2
18H to 1FH	Register Bank 3

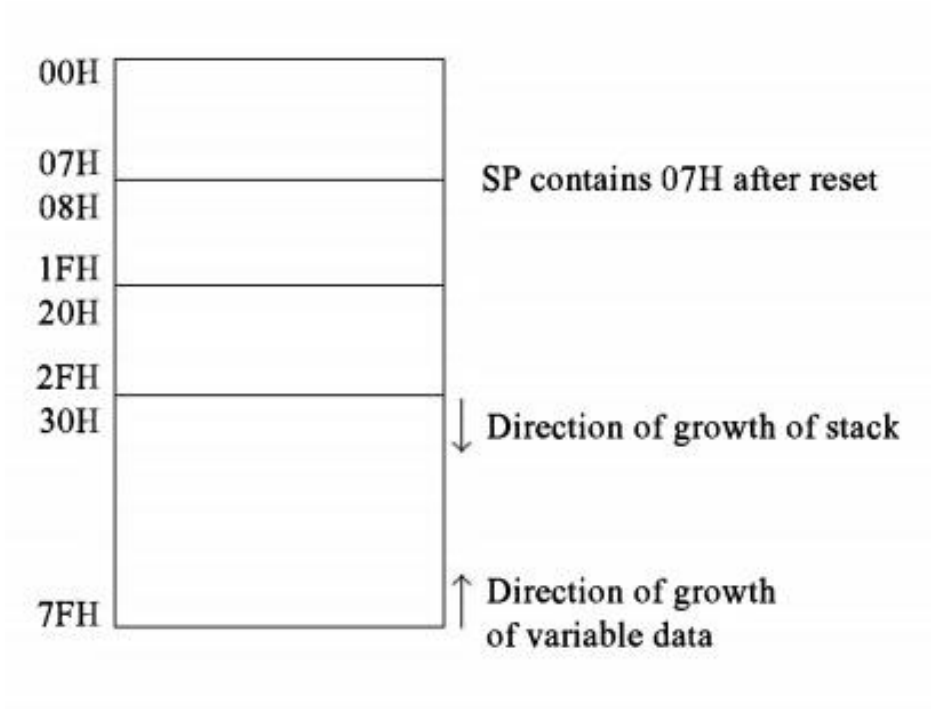
- The concept of four register banks is very useful.
- For servicing the interrupts, this feature is very good.
- The interrupt program can use one bank, and the interrupt Service Subroutine (ISS) can access another bank for better performance.



- When all of the register banks are being used, the scratch pad area will be 20H to 7FH.
- But from 20H to 2FH (16 bytes or 128 bits) can be used as bit addressable RAM.
- By using some simple instructions with 8-bit memory address we can check the bit addressing.
- For an example the instruction CLR 6FH, using this instruction it clears the location 6FH.
- As we know the 8-bit address can locate 256 different locations, but here only128-bits are addressable.
- Another section of bit addressable locations is 80H to FFH. The remaining locations (30H to 7EH) of the RAM can be used to store variable data and stack.

Stack Area

- The stack is a section of a RAM used by the CPU to store information such as data or memory address on temporary basis.
- The CPU needs this storage area considering limited number of registers.
- The stack area in 8051always can be implemented in the internal data memory.
- Here the stack pointer (SP) is an only 8-bit register, because the internal RAM area is only in range 00H to 7FH, and when all register banks are being used, the stack location will be in range 30H to 7FH. So in such a case, the SP will be initialized with 2FH.



- The stack pointer SP increases before each PUSH operation and decreases after each pop instruction.
- When the 8051 is reset, the Stack Pointer will point to 07H.
- It means the location 08H to 7FHcan be used as a stack.
- We are assuming that the register bank 0 is in use and 20H to 27H are not like bit-addressable area.

Thank You